

CLINICAL STUDY

Postoperative complications associated with anterior cervical discectomy and three years follow-up

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ABSTRACT

INTRODUCTION: Anterior cervical discectomy (ACD) is used in the surgical treatment of cervical degenerative disc disease (DDD). Besides the low incidence of postoperative complications, they can affect the postoperative course for patients.

MATERIAL AND METHODS: From January 2015 to December 2019, 789 cervical DDD patients with ACD were investigated. This study aims to identify the risk factors for postoperative complications and evaluate the quality of life for ACD patients using the Visual Analog Pain Scale (VAS) and Neck Disability Index (NDI).

RESULTS: Among the 789 cervical patients, postoperative complications were identified in 88 patients. In analyzing independently risk factors for postoperative complications, we don't record the male gender, age, number of treated segments, diabetes mellitus, and hypertension with significant risk. A BMI higher than 23.5, a longer surgery of more than 82.5 min, and blood loss of more than 95 ml were found as independent risk factors for postoperative complications. The three-year follow-up quality of life was evaluated in 565 because of the loss of 224 patients. We found improved quality of life in the whole group of patients. Moreover, we have not confirmed significant differences in groups of patients, with and without postoperative complications.

CONCLUSION: The result of our study documented a low incidence of postoperative complications after ACD. We identified high BMI level, increased blood loss, and prolonged operation time as independent risk factors for the increased incidence of postoperative complications. Moreover, we demonstrated that postoperative complications do not significantly influence the patient's quality of life (Tab. 5, Ref. 32). Text in PDF www.elis.sk

KEY WORDS: anterior cervical discectomy, cervical degenerative disc disease, postoperative complications, quality of life.

Introduction

Anterior cervical discectomy (ACD) is widely used in the surgical treatment of cervical degenerative disc disease (DDD), including two groups of treatment methods: anterior cervical discectomy and fusion (ACDF) and artificial cervical disc replacement, named cervical disc arthroplasty (CDA). ACDF was described by Smith, Robinson (1) and established by Cloward (2). An anterior approach to the spine is generally preferred to reduce the risk of spinal cord injury. ACDF includes two parts of the surgery: anterior cervical discectomy and fusion. A discectomy is performed by the anterior approach to the cervical spine to remove the disc between two vertebrae. Simultaneously, as part of the discectomy operation, fusion is performed to stabilize the cervical segment. The bone

graft and/or implants are placed instead of the original disc during fusion to achieve strength and stability. An additional front plate or screws are used to enhance the stabilization and improve fusion. These safe and effective procedures present a gold standard cervical DDD therapy with neural decompression, segmental stabilization, and good clinical outcomes. Several new surgical possibilities for treating ACDF for cervical DDD have been developed recently. A stand-alone cage with no plate and no screw has antimigration teeth, such as plate and screw fixation, and a stage-alone cage with fixating screws (3). To prevent cervical spine movement and to minimize adjacent segment disease, CDA was created (4). CDA is another type of surgery that includes removing damaged intervertebral discs and inserting an artificial dynamic or semidynamic disc. These surgical procedures provide restoration of standard disc height and relieve neck pain, shoulder pain, and weakness (5).

ACD performed with fusion ACDF or CDA is a safe and long-term effective surgery indicated for patients with cervical DDD. On the other hand, some complications, such as dysphagia, implant-associated complications (loosening of screws, penetration of screws), neuropathy, perforation of the dura mater, and soft tissue damage, have been documented, especially in multilevel ADC (6, 7). Despite the low incidence of complications in ACD, early

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recognition and correct, rapid, and adequate treatment management are crucial for the postoperative outcome and the patient's quality of life (8).

Material and methods

From January 1, 2015, to December 31, 2019, a prospective study of the surgical results of 789 consecutive ACD patients was performed. Informed consent was obtained from all ACD patients, including those participating in the research. The postoperative complications and clinical outcomes after ACD were evaluated. The study's inclusion criteria were symptoms of cervical DDD with cervical myelopathy and/or radiculopathy, cervical magnetic resonance imaging (MRI) showing intervertebral disc herniation and degeneration, unsuccessful conservative treatment for six months or more, single-level, two-level, and three-level cervical DDD and a minimum of three years of follow-up. The exclusion criteria were a history of previous cervical spine surgery, more than three levels of cervical disc degeneration, other cervical diseases including vertebral fracture, active rheumatic disease or metabolic bone disease affecting the cervical spine, pregnancy, systematic malignancy, or any general severe illness, and a follow-up period

shorter than 3 years. Patients were recorded for gender, age, clinical signs, type of surgical procedures (ACDF; ACDF cage with screw fixation; ACDF with anterior plating, CDA – dynamic, and CDA – semidynamic disc replacement), DM, hypertension, BMI, bleeding during surgery, length of operation, postoperative complications, and quality of life.

The SPSS program (for Mac, Chicago, IL, USA version 29.0) was used for statistical evaluation; data are presented as the means \pm SDs. Differences among groups were determined with one-way ANOVA and the Mann–Whitney test, for multiple comparisons Kruskal–Wallis test. The chi-square test was used, and Fisher's exact test was used to compare the observed occurrence between groups. Odds ratios (ORs) and 95% confidence intervals were used to identify potential complication risk factors. Receiver operating characteristic (ROC) analysis and Youden index were used to find the optimal cutoff value for potential risk factors. For all tests, we chose $p < 0.05$ as the level of statistical significance.

Results

ACD was performed in 789 consecutive patients, with an average age of 50.77 years. Single-level discectomy was performed in 476 patients, and two- and three-level discectomy was performed in 283 and 30 patients. There were no statistically significant differences in the group of patients with and without postoperative complications in age, sex, symptoms of clinical presentation, type of surgical procedures, or level of the treated segment of the cervical spine. Multilevel surgical sites were associated with a higher incidence of postoperative complications, which was statistically confirmed. A longer time of surgery was found in patients with postoperative complications treated with one and three segments but not in patients treated with two segments (Tab. 1).

Early postoperative complications were present in 60 patients (7.60 %), and late complications were present in 28 (3.54 %) of 789 patients. Among the early complications, the most common were dysphagia, present in 26 patients (3.29 %), worsening of neurological deficit in 13 patients (1.64 %), and symptomatic recurrent nerve laryngeal palsy in 7 patients (0.88 %). Postoperative infections occurred in 6 patients (0.76 %), and 1 case required complex surgical intervention. Dural penetration occurred in 3 patients (0.38 %), and postoperative hematoma occurred in 3 patients (0.38 %), with emergency surgical intervention in 2 patients (0.25 %). Horner syndrome occurred in 1 patient (0.12 %) and was temporary. No esophageal perforation was documented in our group of patients. Among the late postoperative complications, adjacent segment disease (ASD) was involved in 24 patients (3.04 %), and implant dislocation was involved in 3 patients (0.38 %) (Tab. 2).

Tab. 1 Characteristics of patients with cervical DDD (n (%)).

Variable	Postoperative complications		p
	present	absent	
Patients	n=88 (11.4) ¹	n=701 (88.64) ¹	
Age, yr	50.38	49.91	0.89
Gender, M/F	40/48 (45.5/54.5) ¹	342/359 (48.8/51.2) ¹	0.94
Patients			
Clinical presentation			
Radiculopathy	38 (42.2) ¹	289 (41.3) ¹	
Myelopathy	26 (30) ¹	203 (28.9) ¹	
Radiculopathy and myelopathy	24 (27.8) ¹	209 (29.8) ¹	0.88
Spinal procedure			
ACDF cage alone 616	56 (9.1) ¹	560 (90.9) ¹	
ACDF cage and anterior plate 14	5 (37.7) ¹	9 (64.3) ¹	
ACDF cage with screw 81	17 (20.9) ¹	64 (79.1) ¹	
Semi dynamic. 66	8 (12.1) ¹	58 (87.9) ¹	
Dynamic 12	2 (16.7) ¹	10 (83.3) ¹	0.96
Spinal level			
Number of treated			
One	36 (7.5) ¹	440 (92.5) ¹	
Two	33 (11.6) ¹	250 (88.4) ¹	
Three	19 (63.3) ¹	11 (36.7) ¹	0.001
Localizations			
C3/4 121	11 (9.1) ¹	110 (90.9) ¹	
C4/5 315	27 (8.9) ¹	288 (91.1) ¹	
C5/6 342	25 (7.3) ¹	317 (92.7) ¹	
C6/7 331	23 (7.2) ¹	308 (92.8) ¹	
C7/Th1 23	2 (8.7) ¹	21 (91.3) ¹	0.90
Length of surgery (min.)			
One	89.72 (65,110) ²	71.48 (50,120) ²	
Two	98.48 (80,120) ²	105.23 (70,150) ²	
Three	146.84 (110,180) ²	111.30 (100,120) ²	0.001

¹Value in percentages, ²Range (minimum, maximum)

Tab. 2. Postoperative complications in 789 ACD patients.

Complication	Patients No 88	Single level 36	Two level 33	Three level 19	p
Early	60	21	23	16	0.0003
Infection 6	6	2	1	3	0.17
Dysphagia 26	26	9	12	5	0.006
Dysphonia (RLN palsy)	7	2	2	3	0.008
Postoperative hematoma	3	1	1	1	0.33
Dural penetration 3	3	1	2	0	0.33
Worsening of neurological deficit	13	5	5	3	0.10
Implant dislocation 1	1	1	0	0	0.31
Horner syndrome 1	1	0	0	1	0.46
Esophageal perforation	0	0	0	0	-
Delayed	28	15	10	3	0.55
Mechanical failure 4	4	1	2	1	0.14
ASD – adjacent segment disease	24	14	8	2	0.83
Tracheoesophageal fistula	0	0	0	0	-

When comparing the occurrence of early and late postoperative complications, it was found that early postoperative complications were significantly increased in cases of multilevel operations. On the other hand, when monitoring late postoperative complications, there was no statistically significant difference in the incidence of postoperative complications in multilevel procedures.

The logistic regression model was used to analyze independent risk factors for the incidence of postoperative complications. Male sex, age, number of treated segments, diabetes mellitus, and hypertension did not significantly influence the presence of postoperative complications. BMI, longer operative time, and blood loss were found to be risk factors for increased postoperative complications. Odds ratios are presented with 95% confidential intervals (Tab. 3).

ROC analysis was performed, and the cutoff value was determined by using the Youden J test. We evaluated a BMI higher than 23.5, length of surgery of more than 82.5 min, and blood loss

of more than 95 ml as independent risk factors for postoperative complications.

For three years of follow-up, we evaluated the patient’s quality of life before and after surgery. From the 789 patients, it was possible to assess the quality of life during the three-year follow-up in 565 patients. A total of 224 patients were lost during the follow-up period; therefore, these 224 patients were not included in the overall evaluation of the quality-of-life of ACD patients.

The patient’s quality of life was monitored using the Visual Analog Pain Scale (VAS) and the Neck Disability Index (NDI). There was an improvement in quality of life when comparing patients before and after surgery at 1, 3, 6, 12, 18, 24, and 36 months. A statistically significant improvement in quality of life and pain reduction was confirmed. The VAS scores were 7.58 before and 1.03 after surgery ($p < 0.001$), and the NDI scores were 43.33 before and 4.24 after surgery during follow-up ($p < 0.001$) (Tab. 4).

The influence of postoperative complications on quality of life was evaluated during the follow-up period. The results of two groups of ACD patients, group 1 with and group 2 without complications, were monitored. We found that the difference between these two ACD patients’ quality of life using the VAS and NDI was not statistically significant. We found that the presence of postoperative complications after ACDF has no considerable influence on the quality of life in patients. Only two times did we evaluate the significantly better quality of life using NDI for ACD patients with and without postoperative complications during follow-up at 1 month and 6 months after surgery. In later follow-ups, the surgery results and the quality of life were similar in both groups of ACD patients with and without postoperative complications (Table 5).

Tab. 3. Logistic regression model for independent risk factors for postoperative complications.

	OR	95% CI	p
Male	0.77	0.45–1.31	0.33
Age	0.98	0.95–1.01	0.25
One/two, three levels	0.61	0.3–1.26	0.183
DM	1.45	0.56–3.72	0.77
Hypertension	1.37	0.8–2.34	0.25
BMI	1.13	1.05–1.21	0.001
Operative time	1.05	1.03–1.06	0.001
Blood losses	1.03	1.02–1.04	0.001

Tab. 4. Evaluation of ACD patients’ quality of life using VAS and NDI scales (mean ± SD).

	Before surgery	Months						p
		1	6	12	18	24	36	
VAS	7.56±0.94	2.76±0.92	2.19±0.59	1.94±0.77	1.62±0.49	1.3±0.46	1.28±0.47	0.001
NDI	43.32±3.35	6.33±2.44	5.76±1.58	5.07±1.26	4.65±0.97	4.49±0.75	4.37±0.48	0.001

Tab. 5. Comparing ACD patients' quality of life using VAS and NDI scores depending on the presence of postoperative complications (mean ± SD).

	VAS	VAS	p	NDI	NDI	p
Postoperative complications	present 76 pts	absent 489 pts		present 76 pts	absent 489 pts	
Before surgery	7.46±0.96	7.57±0.94	0.32	43.22±3.28	43.33±3.28	0.79
Months						
1	2.96±0.82	2.73±0.94	0.71	7.18±2.55	6.19±2.4	0.03
6	2.29±0.51	2.18±0.61	0.23	6.21±1.59	5.69±1.57	0.05
12	2.05±0.78	1.92±0.77	0.15	5.36±1.32	5.03±1.24	0.41
18	1.68±0.47	1.61±0.49	0.28	4.74±0.85	4.63±0.99	0.81
24	1.34±0.48	1.30±0.46	0.52	4.45±0.6	4.49±0.77	0.58
36	1.29±0.48	1.27±0.47	0.82	4.39±0.49	4.37±0.48	0.73
p	<0.001	<0.001		<0.001	<0.001	

Discussion

ACD is currently a standard and common neurosurgical operation for cervical DDD patients with a relatively low risk of intraoperative and postoperative complications. In recent studies, the morbidity rate for ACD varies from 10 % to 20 % (6–10). Early postoperative complications are more common than late complications. These include wound infection, dysphagia, dysphonia due to recurrent laryngeal nerve palsy, postoperative hematoma, penetration of dura mater with cerebrospinal fluid leakage, worsening of neurological deficit, implant dislocation, Horner syndrome, and esophageal perforation. Late postoperative complications can present as mechanical failure, adjacent segment disease (ASD) that could require an operation, tracheoesophageal fistula, and pseudoarthrosis, which increases with the number of treated segments (6, 8).

The incidence of infectious complications associated with ACD reported in the literature is 0.1–1.5 % (6–8). In our group of 789 patients operated on in 2015–2019, an infectious complication was recorded in 6 patients, representing 0.76 %. In all 6 patients with postoperative infection, multilevel discectomies were performed in 4 patients. Veeravagu et al reported a higher incidence of infections in the surgical wound after cervical intervertebral disc operations associated with patients with comorbidities and over 65 years of age. In this paper, the authors found that abscess and infection are the most common causes of repeated admission to the hospital (9).

During an anterior cervical approach to the spine, the infection can be associated with another severe complication, iatrogenic injury to the esophagus during surgery. Its incidence is described in the literature as 0.3–3.4 % (7, 11, 12). Gamain et al (12), in a set of 1475 patients after anterior cervical discectomies, recorded 5 infectious complications, of which only 3 cases were associated with esophageal perforation, but they did not record the death of the patients. Fountas et al published the incidence of esophageal perforation during anterior cervical disc surgery in 3 patients out of a total of 1015, which represented 0.3 %. They also recorded one case of exitus associated with this complication, 0.1 %. Therefore, they emphasize close monitoring of patients with postoperative infectious complications and immediate surgical revision in the

case of confirmed esophageal perforation (8). Brinster et al (12) reported that early recognized iatrogenic perforations of the esophagus have a good prognosis. This complication is still associated with relatively high mortality, up to 16 %, especially if identified late. Risk factors for esophageal perforation include previous neck surgery and previous cervical radiation. The treatment of detected esophageal perforation also remains controversial. Some authors recommend a conservative procedure in treating esophageal injury, especially in patients with late-recognized perforation and minimal clinical findings (14, 15). Most authors recommend immediate surgical revision and reconstruction in cases of early recognized esophageal perforation (13, 15). In our follow-up of 789 patients over 5 years, esophageal perforation in connection with anterior cervical discectomy and fusion or application of intervertebral disc replacement was not recorded.

Some patients may have discomfort while swallowing, presenting as dysphagia, following ACD. Usually, postoperative dysphagia after ACD is temporary or transient in most cases and resolves within a few weeks or months, and persistent occurrence is rare (16). The presence of wound hematoma, bleeding, soft tissue swelling around the prevertebral area, nerve injuries, esophageal retraction, and inflammation due to implant material can increase the incidence of dysphagia (20). It occurs more frequently in patients with multilevel operations than in patients with one level (9). Elderly patients (aged > 60 years) and myelopathy patients with preexisting dysphagia are also associated with a high risk of postoperative dysphagia (17). In the study by Tsalimas et al (18) the authors evaluated the occurrence, pathogenesis, diagnosis, and methods of preventing dysphagia in patients with ACDF. They found that female sex, smoking, and multilevel surgery are risk factors for postoperative dysphagia. The authors identified that zero-profile devices without screws and plates could reduce dysphagia risk. In our group of 789 patients, dysphagia occurred in 26 patients (3.2 %).

Recurrent laryngeal nerve (RLN) injury is a severe complication associated with ACD, with an incidence in different studies from 0.2–16.7 % (7, 19). Injury of the RLN occurs directly during surgery by contact with the RLN or indirectly because of compression secondary to traction. Sometimes injury to the RLN is due to intubation or endotracheal cuff inflation (20, 21). The clinical

presence of RLN palsy includes primary dysphonia, dysphagia, and aspiration. These symptoms are usually mild and transient with the possibility of conservative treatment. Conversely, a minority of patients could develop permanent deficits and require surgical interventional treatment, tracheostomy, or tracheal plastic surgery (22). There are some risk factors for RLN palsy after ACDF, such as secondary in comparison with primary surgery (23), increased intraoperative time (24), and a right-sided approach, probably because of a more oblique course and a shorter right-side RLN than the left-side RLN (8). On the other hand, Kilburg et al found no significant differences in comparing right- and left-sided ACDF procedures (25). Lied et al identified that the number of operated levels can be associated with an increased incidence of RLN palsy; therefore, multilevel cervical disc operations can be a potential risk factor (26). Dysphonia due to RLN palsy was diagnosed in our group of patients in 7 cases. All cases of RLN palsy were mild and transient.

Bleeding can occur after all surgical procedures, but after ACD, postoperative bleeding and hematomas are rare. Usually, they can be present a few hours after surgery. Retropharyngeal hematomas due to compression can lead to acute airway compromise (27). Therefore, immediate recognition and removal are critical to limit morbidity and mortality. Micolli et al (28) reported a case of patient after two-level ACDF with acute respiratory distress due to a large right-lateral retrotracheal hematoma requiring emergency surgery five days after surgery. The source of hematoma was injury to a branch of the superior thyroid artery. Early postoperative hematomas can develop within a few hours after surgery. Late hematomas can present with acute respiratory distress and can be seen a couple of days after ACD procedures. Investigating postoperative complications in our group of patients, we documented early postoperative hematomas in 3 patients.

Epstein and Agulnick in 2022 (29) reported the incidence of ASD following ACDF and CDA. ASD in radiographic images was present in 2–4 % of patients per year for both ACDF and CDA surgical procedures. Both treatment methods show a lower incidence of symptomatic ASD. Moreover, only a few cases of symptomatic ASD must be treated with secondary surgery. They confirmed an increase in ASD in multilevel segment cervical spine surgery. The authors recommended limiting surgery to only essential levels. In our group of 789 ACD patients, ASD was confirmed in 24 patients.

Suk et al (30) evaluated risk factors and the incidence of graft failure during ACDF. Their study showed that graft failure occurred more commonly in multilevel ACDF surgery. The authors identified the pedicle screws as the best biomechanical stability surgical methods for ACDF compared to plate and stand-alone procedures.

Several recent studies confirmed improvement in quality of life after ACD (19, 21, 32). Butterman (31) evaluated 159 ACDF patients in a prospective study during a 10-year follow-up period. He confirmed improved quality of life during the follow-up compared to preoperatively. He did not find a statistically significant influence of patient age, sex, or the incidence of multilevel discectomy on postoperative outcomes. During the 10-year study, he documented additional surgery for pseudarthrosis. ADS occurred in 10 % of patients in the early follow-up period and in 21 % of patients in

the later. During the 10-year follow-up period, the author found that the presence of ADS increased linearly. Recently, more than 20 years of follow-up results of ACDF patients were published by Hermansen et al (32). The authors confirmed that the postoperative NDI score significantly decreased over time. In our group of ACD patients, we found improvement in quality of life and a significant decrease in neck pain using the VAS and NDI scoring systems.

Conclusion

Despite the low incidence of postoperative complications associated with ACD in cervical DDD patients, their early recognition and treatment are essential for the success of ADC surgery. In our research, several risk factors for postoperative complications were identified; among them, the most important seems to be a BMI higher than 23.5, a longer operative time than 82.5 min, and blood loss greater than 95 ml. We evaluated the improvement in quality of life in a whole group of ACD patients over a 3-year follow-up period. Moreover, the results of our research found that the presence of postoperative complications did not have a significant influence on long-term quality of life.

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