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Comparison of adjacent segment degeneration in patients using cervical cage and disc prosthesis in anterior cervical surgery

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ABSTRACT

Aim: To examine the prevalence of adjacent segment degeneration associated with the use of cages and disc prostheses in patients who underwent cervical disc surgery via an anterior cervical approach.
Methods: We retrospectively reviewed the medical records of 60 patients who underwent cervical disc surgery via an anterior cervical approach at our clinic between 2018 and 2023. The patients were divided into two groups based on the type of implant used: those with a cervical cage (Group 1) and those with a cervical disc prosthesis (Group 2). Patients' demographic and clinical details, including age, gender, smoking habits, follow-up durations, and any additional comorbid diseases, were recorded. Radiological evaluations focused on degeneration rates in the segments adjacent to where either the cage or disc prosthesis was implanted.
Results: In the study comparing two groups, participants' average ages were 48.9 in Group 1 and 48.1 in Group 2 (p=0.720). Group 1 had a higher proportion of smokers (p=0.052) and more discopathy (p=0.196). In terms of disc degenerations, variations existed but were not statistically significant (p=0.259). Utilizing the Pfirrmann grading, Group 1 had more Grade III degeneration (p=0.088) and a significantly higher presence of ossification or osteophytes (p=0.038). Both groups showed high rates of adjacent segment degeneration, yet Group 1 had notably more proximal degeneration (p=0.012). Stenosis and facet hypertrophy differences were not significant (p=0.417, p=0.071). Follow-up duration averaged around 38 months for both groups (p=0.929).
Conclusions: No substantial difference in the overall incidence of adjacent segment degeneration between the two procedures. Nevertheless, further large-scale and long-term studies are essential to draw comprehensive conclusions regarding the optimal surgical intervention for cervical disc ailments.

Keywords: Cervical degenerative disc disease, adjacent segment disease, cervical cage, cervical disc prosthesis.

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Introduction

In recent times, there has been an observable increase in degenerative disorders associated with the cervical spine. These disorders present substantial challenges to medical professionals, increasingly requiring surgical solutions [1]. Despite notable progress in the development of disc replacement techniques and prosthetic designs, Anterior Cervical Discectomy and Fusion (ACDF) continues to be the most reliable and prevalently endorsed surgical approach for addressing cervical disc pathologies [2].

The predominant preference for ACDF is largely due to its consistent safety profile, effectiveness, and the predictability of outcomes. However, there are growing concerns among some experts regarding the potential long-term consequences of ACDF. These concerns specifically relate to the creation of a more rigid functional unit in the cervical spine following the procedure, which may adversely affect the adjacent segments (AS) [3].

To address these concerns, in earlier times, surgeons turned to the Bryan cervical disc arthroplasty (BCDA). This technique was lauded for its ability to preserve the natural movement and alignment of the operated cervical level. Additionally, it was believed that BCDA significantly reduced the stress on the AS, especially when compared to the traditional ACDF procedures [4-6]. However, the latest comparative studies conducted on a prospective basis suggest that when it comes to the degeneration of adjacent segments, BCDA and ACDF might, in fact, offer comparable outcomes [7,8].

In this study, we aimed to examine the prevalence of adjacent segment degeneration associated with the use of cages and disc prostheses in patients who underwent cervical disc surgery via an anterior cervical approach.

Materials and methods

Study design and participants

We conducted a retrospective review of the medical records of 60 patients who underwent cervical disc surgery through an anterior cervical approach at our clinic from 2018 to 2023. The study was approved ethically by non-interventional ethics committee of Sancaktepe Ilhan Varank Hospital (date: 11/10/2023 – No: 206). Written informed consents were obtained from all patients and/or their guardians.

These patients were categorized into two groups based on the type of implant employed: Group 1, consisting of patients with a cervical cage (Figure 1A), and Group 2, comprising those with a cervical disc prosthesis (Figure 1B).

Patients' demographic and clinical details, including age, gender, smoking habits, follow-up durations, and any additional comorbid diseases were recorded.

All patients underwent bi-directional cervical x-rays and cervical magnetic resonance (MR) imaging. Radiological evaluations focused on degeneration rates in the segments adjacent to where either the cage or disc prosthesis was implanted (Figure 1C). The presence of discopathy, ossification or osteophytes, facet hypertrophy, stenosis, scoliosis, and listhesis were used as criteria to determine degeneration. Furthermore, discopathy and disc degeneration differentiation were staged according to the Pfirrmann grading system [9] (Table 1).

Inclusion criteria

Only patients with single-segment cervical disc diseases due to cervical degeneration were included in this study.

Exclusion criteria

Patients with traumatic disc injuries due to cervical trauma, surgeries involving anterior cervical plates, and surgeries where a cage or prosthesis was applied to two or more segments in either group were excluded from this study. Additionally, As a result of the retrospective analysis, patients with insufficient file record data and those with irregular data were excluded from the study.

Statistical analysis: Patient data were analyzed using various statistical methodologies, which included generating descriptive statistics, determining frequencies, and evaluating other factors across all categories. Quantitative data were expressed as mean ± standard deviation. Normality of continuous variables was checked

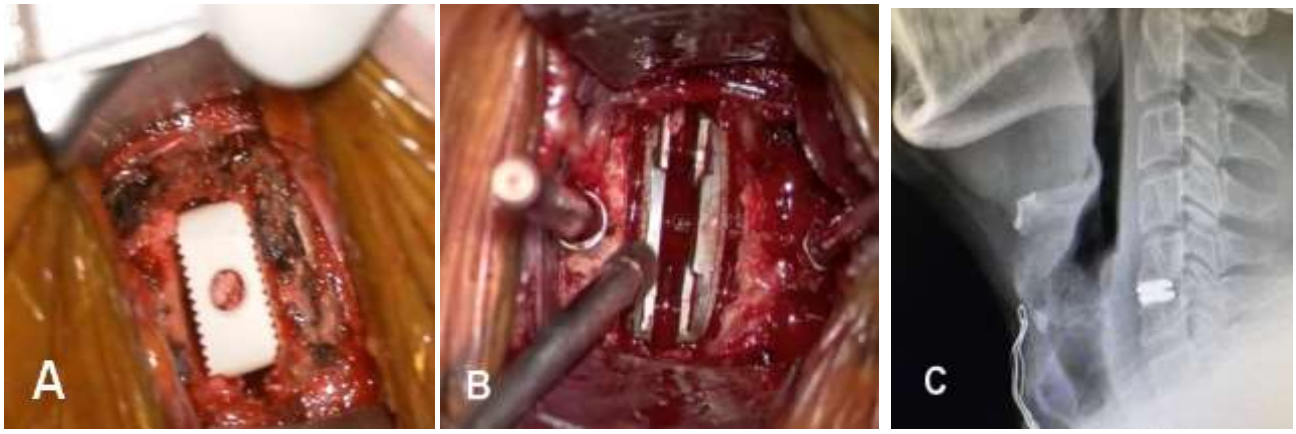

Figure 1. A) Preparation and placement of the cervical cage site. **B)** Preparation and placement of the cervical disc prosthesis. **C)** X-ray of the cervical spine after cervical disc prosthesis placement.

Table 1. Pfirrmann grading system [9].

Grade	**Definitions**
Grade I	A normal disc
Grade II	An inhomogeneous disc with normal disc height and a clear difference between the nucleus and annulus
Grade III	An inhomogeneous gray disc with a loss of the clear border between the nucleus and annulus and normal to slightly decreased disc height
Grade IV	An inhomogeneous hypointense dark gray disc with significant disc height loss
Grade V	A inhomogeneous black disc with disc space collapse

using Shapiro-Wilk and Kolmogorov-Smirnov tests for normality. For normally distributed continuous variables, Student's t-test was applied. Non-parametric tests were employed when the data did not follow a normal distribution. The categorical variables were tested with Chi-Square test. Data was processed with SPSS Statistics for Windows, Version 24.0 (IBM Corp., Armonk, NY, USA). A two-tailed p-value of ≤ 0.05 was considered statistically significant.

Results

Co-morbidities of the patients are presented in Table 2. It was found to be most frequently accompanied by gastritis and hypothyroidism.

Comparison of the demographic and other parameters of the patients is presented in Table 3. The study involved a total of 60 participants, divided equally into two groups: Group 1 (n=30) and Group 2 (n=30). The average age of participants in Group 1 was 48.9±10.6 years, compared to 48.1±9.48 years in Group 2 (p=0.720). The male representation was slightly higher in Group 1 with 19 males (63.3%), compared to 15 males (50%) in Group 2; however, the difference was not statistically significant (p=0.297). The proportion of smokers in Group 1 was considerably higher (80%) than in Group 2 (56.7%), but this difference

Table 2. Comorbidities.

Comorbidity	**n**	**%**
Asthma	1	1.7
Allergic Rhinitis	2	3.3
Anemia	2	3.3
Basedow Graves	1	1.7
Gastritis / GERD*	13	21.7
Glaucoma	1	1.7
Gonarthrosis	3	5.0
Hyperlipidemia	3	5.0
Hypertension	4	6.7
Hypothyroidism	7	11.7
Coronary Arterial Disease	3	5.0
Breast Cancer	1	1.7
Uterine Cancer	1	1.7
Arthritis	3	5.0
Diabetes	4	6.7
None	11	18.3
Total	60	100

**GERD: Gastroesophageal reflux disease.*

approached significance (p=0.052). Discopathy was more common in Group 1, with 56.7% of patients affected, compared to 40% in Group 2 (p=0.196). Concerning the number of disc degenerations, Group 1 had 16.7% with 0 discs affected, 83.3% with 1 disc, and none with 2 discs. In contrast, Group 2 had 30% with 0 discs, 66.7% with 1 disc, and 3.3% with 2 discs affected (p=0.259) (Table 3).

Using the Pfirrmann disc degeneration grading system; Grade I degeneration was observed in 30% of Group 1 and 43.3% of Group 2. Grade II was seen in 26.7% of Group 1 compared to 40% in Group 2. Grade III was notably more frequent in Group 1 at 43.3% as opposed to only 16.7% in Group 2 (p=0.088). Ossification or osteophyte presence was significantly higher in Group 1 (66.7%) than

Table 3. Comparison of the groups.

Parameters	**Group 1 (n=30)**	**Group 2 (n=30)**	***p*-value**
Age (year)*	48.9±10.6	48.1±9.48	0.720
Gender (M)	19 (63.3%)	15 (50%)	0.297
Discopathy	17 (56.7%)	12 (40%)	0.196
Number of disc degeneration			0.259
0 disc	5 (16.7%)	9 (30%)	
1 disc	25 (83.3%)	20 (66.7%)	
2 discs	0 (0%)	1 (3.3%)	
Pfirrmann disc degeneration grade			0.088
Grade I	9 (30%)	13 (43.3%)	
Grade II	8 (26.7%)	12 (40%)	
Gerade III	13 (43.3%)	5 (16.7%)	
Ossification/osteophyte	20 (66.7%)	12 (40%)	**0.038**
Stenosis	12 (40%)	9 (30%)	0.417
Facet hypertrophy	18 (60%)	11 (36.7%)	0.071
Scoliosis	2 (6.7%)	2 (6.7%)	1.000
Listhesis	4 (13.3%)	2 (6.7%)	0.389
ASD[&]	28 (93.3%)	24 (80%)	0.129
Location of the degeneration ASD[&]			**0.012**
Distal	4 (14.3%)	11 (45.8%)	
Proximal	14 (85.7%)	13 (54.2%)	
Smoking	24 (80%)	17 (56.7%)	0.052
Follow-up (month)*	38±17	38.4±14.5	0.929

**Mean ± standart deviation. [&]Adjacent segment degeneration.*

Group 2 (40%) (p=0.038). Stenosis affected 40% of Group 1 and 30% of Group 2 patients (*p*=0.417), while facet hypertrophy was observed in 60% of Group 1 and 36.7% of Group 2 (*p*=0.071). Scoliosis (6.7% in both groups) and listhesis (13.3% in Group 1 and 6.7% in Group 2) demonstrated no significant differences between groups (*p*=1.000 and *p*=0.389 respectively) (Table 3).

Adjacent segment degeneration was high in both groups, affecting 93.3% in Group 1 and 80% in Group 2 (*p*=0.129). However, when considering the location of the degeneration; distal degeneration was observed in 14.3% of the affected Group 1 patients and 45.8% of affected Group 2 patients. Proximal degeneration was notably higher in Group 1 at 85.7%, compared to 54.2% in Group 2, and this difference was statistically significant (*p*=0.012). The follow-up period showed a nearly equal average of 38±17 months for Group 1 and 38.4±14.5 months for Group 2 (*p*=0.929) (Table 3).

Discussion

Although ACDF has been acknowledged as the standard procedure for addressing cervical disc degeneration in recent decades, numerous Randomized Controlled Trials (RCTs) suggest that cervical Total Disc Replacement (cTDR) may provide comparable, or potentially superior, clinical outcomes in comparison to ACDF. A recent analysis by Cochrane Review supports this perspective but emphasizes the necessity for medium to long-term follow-up evaluations [10]. The cervical spine and its associated degenerative conditions have been an area of increasing interest within the medical community [11]. In our study, we delved deep into the comparative outcomes of patients who underwent cervical disc surgery via an anterior cervical approach, focusing primarily on the incidence of adjacent segment degeneration between those with a cervical cage and those with a cervical disc prosthesis.

While ACDF has been a stalwart surgical technique for cervical disc conditions due to its consistent positive outcomes, the potential long-term implications, especially concerning adjacent segment degeneration, have been a topic of debate [10-12]. The BCDA emerged as an alternative, largely due to its ability to maintain the natural motion of the cervical spine, theoretically reducing stress on adjacent segments. To counteract the biomechanical strain on adjacent segments, the use of anterior cervical discectomy combined with arthroplasty has been suggested [13-15]. Some research points out that cervical disc arthroplasty leads to improved clinical results, reduced cases of adjacent segment conditions, and fewer repeat surgeries, given that it maintains the natural range of motion in the cervical spine [16-18]. On the other hand, there's evidence that certain prosthetic devices can develop heterotopic ossification, leading to full fusion in the operated segment, which could limit cervical movement without necessarily affecting clinical signs [13,14,19,20]. Additionally, the cervical disc arthroplasty cohort has reported increased rates of subsequent surgeries, with the predominant reason being the prosthesis becoming unstable or settling [21-23]. Yet, our findings suggest that when considering the degeneration of adjacent segments, both procedures might offer similar outcomes. The prevalence of discopathy and ossification or osteophyte presence was higher in the cervical cage group, pointing to the potential implications of using cages in terms of degeneration. Our results revealed no significant difference in age or gender between the two groups, ensuring that the outcomes observed weren't skewed by these demographic factors. However, notable variations were evident in other parameters.

One notable observation from the study was the marked variation in the site of adjacent segment degeneration between the two patient groups. Those receiving a cervical cage predominantly exhibited degeneration at proximal segments, whereas patients with a cervical disc prosthesis tended to show degeneration at distal segments. This finding holds significant implications for surgical planning. Knowledge of the probable site of future degeneration could play a pivotal role in shaping post-operative strategies and long-term patient management protocols.

The limitations of our study, with its retrospective design, is prone to potential biases stemming from non-randomized patient selection. Additionally, with a sample size of just 60 patients, the capacity to generalize our findings to a broader populace is questionable. We confined our research to single-level diseases, thereby overlooking potential variations in more complex cases. Unfortunately, factors such as postoperative alignment changes, diverse smoking habits, physical activity levels, occupations, and specific surgical methodologies weren't addressed. The exclusion of multi-segment surgeries possibly narrows the study's relevance to intricate clinical situations. While we depended solely on radiographic assessments, including a biomechanical analysis could yield deeper insights. Furthermore, extending the follow-up periods might offer a clearer understanding of long-term implant impacts on ASD.

Conclusions

In the quest to address cervical spine degenerative conditions, both cervical cages and disc prostheses present unique advantages and challenges. While our research found no substantial difference in the overall incidence of adjacent segment degeneration between the two procedures, the location of this degeneration did vary. Cervical cages showed a predisposition towards proximal degeneration, whereas disc prostheses were linked with distal degeneration. This finding might hold clinical significance for future surgical planning and post-operative patient care. Nevertheless, further large-scale and long-term studies are essential to draw comprehensive conclusions regarding the optimal surgical intervention for cervical disc ailments.

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