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Evaluation of Adjacent Segment Degeneration after Cervical Spine Surgery: Arthroplasty Versus Fusion

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Abstract

Background: Anterior Cervical Discectomy and Fusion (ACDF) is an effective treatment for disc herniations; but some studies demonstrated that in the untreated levels adjacent to a fusion, increased motion might lead to an increased risk of adjacent segment degeneration (ASD). On the other hand, methods of cervical Disc Arthroplasty (CDA) have improved. The aim of this study is to evaluate and compare the rate of ASD in patients who underwent ACDF or CDA cervical spine surgery.**Methods and Materials:** This prospective study was performed on 84 patients with cervical radiculopathy due to single-level disc herniation referred to hospitals in Tehran, Iran from June 2011 to December 2012. All subjects were randomly allocated to Group A or Group B to undergo ACDF or CDA, respectively. The validated Neck Disability Index (NDI) questionnaire was used to assess the cervicalneck pain. **Results:** The mean of age in Group A was 51.7 ± 9.1 years and in Group B was 49.3 ±9.2. The differences in cervical radiculopathy in the two groups were not statistically significant. The difference in mean Visual Analogue Scale (VAS) score in the two groups at each assessment time was statistically significant. Mean NDI score before the surgery was 46.9 ± 6.1 in group A, and 41.3 ±4.7 in group B. The mean NDI score improved significantly in group B. Twenty-seven of the patients in Group A experienced ASD at 12 months compared to one patient (2.3%) in Group B ($P<0.05$).
Conclusions: According to the findings of this study, CDA leads to reduced VAS and NDI score compared to ACDF. Also increased ASD in ACDF was demonstrated when compared with CDA after 1-year follow-up. **[GMJ. 2013;2(1):12-17]**

Keywords: Arthroplasty, Adjacent Segment Degeneration, Cervical Spine, Fusion

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Introduction

Chronic neck pain is one of the most common musculoskeletal disorders, presenting in 60% of patients for a period longer than 5 years.[1-3] Some studies have shown 14% of patients reporting Grade II to IV neck pain, can be defined as having high pain intensity with disability.[4] Thus, chronic neck pain not only limits performance, but also has a significant impact on the economy and health.[2,4] Among the multiple structures responsible for neck and upper extremity pain; cervical intervertebral discs, cervical facet joints, ligaments, fascia, muscles, and nerve roots are the most important factors.[5] Overall, cervical disc herniation with radiculitis is regarded as one of the most common conditions of neck and upper extremity pain.[6,7] Also cervical spondylosis is the most frequent cause of cervical radiculopathy and myelopathy in older patients.[8]Usual clinical findings of myelopathy include hyperreflexia, disabling disturbances of gait, clonus, equilibrium, coordination, and difficulty handling small objects.[9] The main goal of all treatment techniques is to decompress the affected neural structure, and to advance fixation techniques as well as motion-preserving options.[10,11]

In the early twentieth century, cervical radiculopathy symptoms were attributed to compression of the brachial plexus by the anterior scalene muscle.[12] Anterior Cervical Discectomy and Fusion (ACDF) is regarded as a gold standard treatment for degenerative cervical spine disease that was originally explained over 50 years ago.[13] This method represents the standard treatment for cervical spondylolytic radiculopathy and myelopathy and its aim is to achieve solid fusion, fitting compressive loading of the graft and stability. As fusion may cause ASD, artificial discs have been introduced as motion-preserving devices to decrease the risk of fusion-related complications.[14] Numerous studies have demonstrated the effectiveness of ACDF; patients generally experience rapid recoveries, and dramatic improvement in their quality of life .[15] Nevertheless, it is assumed that fusion can increase the stress on adjacent segments and accelerate the degradation process.

Therefore, the technique of a non-fusion operation was developed for preserving movement functions and reducing physical stress injuring of the adjacent segments. In the first decade of the 21st century, non-fusion operations such as Cervical Disc Arthroplasty (CDA) have been improved (16). CDA may decrease the chances of developing ASD and segment breakdown by maintaining normal disc kinematics.[17]

However, few clinical studies have specifically aimed to evaluate ASD after CDA.[18]

This study aimed to evaluate the ASD in patients who underwent ACDF as Compared with CDA after cervical spine surgery.

Methods and Materials

Subjects

This prospective study with random sampling was performed on 84 patients aged from 18 to 65 years old with cervical radiculopathy due to single-level disc herniation who were referred to Boo–Ali and Laleh hospitals in Tehran, Iran from June 2011 to December 2012. The study was approved in the ethical committee of Tehran Medical Branch, Islamic Azad University, Tehran, Iran, and written informed consents to participate in the study were collected. Patients with single-level symptomatic degenerative disc, more than 8-weeks persistence and severe neck and arm pain, unresponsive to non-surgical management such as physical therapy, and anti-inflammatory medication were eligible to enroll in the study. Exclusion criteria included severe cervical spondylosis, osteoporosis, multi-level cervical degenerative disc disease, and cervical instability. All patients' diagnoses were confirmatory by neurological examination and X-rays, as well as magnetic resonance imaging (MRI).

Randomization

Patients were assigned randomly by sealed envelopes. Forty-two patients received ACDF (Group A) in single level with HRC® cage (Euro spine company, France) and 42 patients received single-level CDA (Group B) with Discoserv® prostheses (Scint'x company, France).

Surgery procedures

All patients were positioned supine with the neck in a moderately hyperextended position or slightly extended under general anesthesia. Standard right-sided anterior approach through a 5-6cm transverse incision extending to the medial border of the sternocleidomastoid was used for discectomy and fusion (or disc arthroplasty) in all patients. Medial to the carotid sheath, the pre-vertebral space was opened and the anterior cervical spine was exposed. Two distraction pins and the Caspar spreader were placed in the affected segment. The anterior longitudinal ligament is removed and the nerve root and dura were decompressed adequately. Once the anterior discectomy was performed, an interbody cage filled with bone substitute was placed within the intervertebral space under fluoroscopic guidance. To prevent pain from the iliac crest, no autologous bone was used.

Data collection

At baseline, demographic data, involving patient's socioeconomic level, smoking status, pain history and pain location were collected. Clinical symptoms such as cervical and arm pain were investigated preoperatively and postoperatively in 1 week, and 3, 6 and 12 months after the operation. Visual analogue scale (VAS) was used for grading arm pain (0 no pain to 10 severe pain). The validated Neck Disability Index (NDI) questionnaire was used to assess cervical neck pain. Radiographic evaluation including AP and static and dynamic flexion-extension lateral images with the patient in the standing position, was also performed by an independent radiologist preoperatively and postoperatively at 1 week, and 3, 6, and 12 months after the operation.

Data Analysis

Descriptive statistics with measures of the central tendency and dispersion (±SD) were employed for continuous variables and proportions and percentages in case of nominal variables. For survival analysis of ASD, the Kaplan–Meier test was applied. The data was analyzed by SPSS version 14.0 (SPSS Inc, Chicago, IL). Significant difference was set at $P<0.05$.

Results

The mean age in Group A was 51.7 ± 9.1 years and in Group B was 49.3 ±9.2. In the group A, 52.3% (n = 22) and in the group B, 45.2% (n = 19) were men. Baseline characteristics are shown in Table-1.

The difference in cervical radiculopathy in the two groups (86% compared to 88.4%) were not statistically significant (P = 0.74). The most common involved segment in group A was C6-C7 (38%) and in group B was C5-C6 (54.7%).

In both groups: the number of Blood transfusion required during surgery was not statistically significant (P = 0.36); Also, the difference in mean VAS arm pain score at pre-op was not statistically significant (P = 0.54). While VAS score at 1 week (P = 0.01), 3 months (P = 0.04), 6 months (P = 0.005), and

Table 1. Some characteristics of Patients

	Group A (n=42) n(%)	Group B (n=42) n(%)	P-value
Age (mean±SD)	51.7 ± 9.1	49.3 ± 9.2	0.90
Gender			
Male	22(52.3)	19(45.2)	0.18
Female	20(47.6)	23(54.7)	0.18
Smoking	14(33.3)	17(40.4)	0.25
Pain location			
Neck	3(7.1)	1(2.3)	0.07
Shoulder	3(7.1)	3(7.1)	0.93
Arm	12(28.5)	9(21.4)	0.63
Hand	2(4.7)	2(4.7)	0.93
More than one site	22(52.3)	27(64.2)	0.42
Involved Segment			
C3-C4	6(14.2)	5(11.9)	0.08
C4-C5	6(14.2)	8(19)	0.66
C5-C6	14(33.3)	23(54.7)	0.36
C6-C7	16(38)	6(14.2)	0.14

12 months (P = 0.007) after surgery was statistically significant (Table-2).

Mean NDI score before the surgery was 46.9 ± 6.1 in group A, and 41.3 ±4.7 in group B. The mean NDI score improved significantly in group B (Figure-1).

Twenty-seven (64.2%) of the patients in Group A experienced ASD at 1-year follow-up compared to one (2.3%) in Group B (P<0.05).

Through radiological evaluation, mean range of motion (ROM) from flexion/extension of the treated patients in group A averaged to about 7.3° (range 0–24°) pre-operatively, and 6.4° (range 0–24°) at 1-year follow-up. At the adjacent levels, ROM averaged to 14.6 ± 3.1° pre-operatively and 18.8 ± 1.4° after 1 year, respectively (P = 0.03). In group B the ROM at the adjacent levels did not show any significant difference at 1-year follow-up versus pre-operatively (P=0.08).

Discussion:

The results of this study showed that the mean VAS score was reduced significantly at 1 week, and 3, 6 and 12 months in CDA group. In both groups, there was a significant improvement in NDI score after 1-year follow-up.

Table 2. Arm VAS score before and after surgery

	Group A (mean±SD)	Group B (mean±SD)	P-value
Pre-op	29.2 ± 2.8	33.7 ± 1.8	0.54
1 week	15.3 ± 3.1	10.9 ± 2.2	0.01
At 3 month	12.6 ± 2.7	10.7 ± 1.9	0.04
At 6 month	9.1 ± 4.2	6.4 ± 3.3	0.00
At 12 month	6.9 ± 1.7	5.3 ± 2.8	0.00

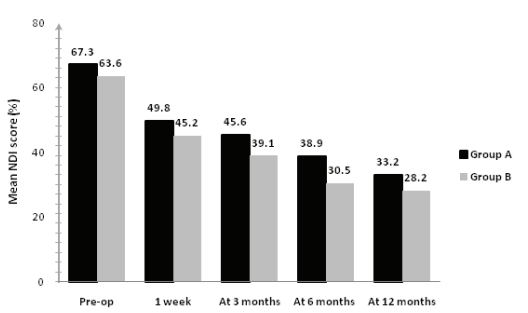

Figure 1. Cervical NDI score before and after surgery

Sasso et al reported that mean pain scores are significantly lower in the fusion group compared with arthroplasty group.[19] While Kim et al showed Reduction rate in VAS scores were similar in both groups.[20]

Previous studies demonstrated a significantly better function for the CDA group in tests of functional outcome, NDI and VAS. Marked improvement was seen in all tests in both study groups 1 week after surgery.[21]

Lafuente et al conducted a clinical study involving 46 patients with single-level CDA. VAS and NDI improved in a statistically significant manner in all patients.[22]

In a study on 46 patients with single-level CDA, Yoon et al reported that arm pain VAS increased from 5.32 to 6.9 and NDI increased from 67% to 75% at 12 months after surgery.[11]

In the present study, the difference in ROM was statistically significant only in ACDF group (P < 0.05). However, segmental motion at adjacent levels showed a significant increase in ACDF group. Disc arthroplasty preserves the motion of the treated segment, and this preserved motion could contribute to the better functional performance of this procedure over ACDF. On the other hand, Emery et al reported an increase in overall cervical motion of the patients in long-term.[23]

Wigfield et al compared the ROM between patients with ACDF and patients with CDA. The ACDF group demonstrated a higher segmental motion at the adjacent level in comparison to CDA.[24] Moreover, Reitman et al reported no significant difference in ROM at the adjacent level in ACDF. Also, they noticed that there were no Radiological changes indicative of degenerative disc disease at adjacent levels.[25]

The results of this study showed that adjacent disc disease is higher in first ACDF compared with CDA. Harrop et al reported ASD in 34% of ACDF group as compared to 9% in the CDA group.[26] Previous studies suggested that degenerative disc disease may develop with or without alteration in cervical motion.[27]

Subsequently, adjacent level disease may be the result of degeneration progression due to altered cervical movements post fusion. Robertson et al assessed the appearance of new radiological degenerative changes or the ra-

diological signs of increase in an existing degenerative disc disease at an adjacent segment of a single level surgery.[28] There is a growing concern about the adjacent level disease among spine surgeons. It is supposed that the presence of a fusion could increase load and segmental range of motion at adjacent levels and cause localized trauma with subsequent accelerated disc degeneration.[29,30]
However, there is a general agreement to consider CDA as an efficient and reliable treatment for cervical degenerative disc disease based on clinical outcomes and patient benefits.

Conclusion:

In view of findings from the present study, CDA leads to reduce VAS and NDI score compared with ACDF. Also an increase ASD in ACDF was demonstrated, when compared with CDA after a 1-year follow-up.
Further studies on larger groups with longer follow-up periods are recommended in order to be able to make further reliable conclusions.

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