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Research Article

Functional and Quality of Life Outcomes of Surgery for Degenerative Cervical Myelopathy: a Quality Improvement Study

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Abstract

Background: This study aimed to determine the outcome of surgical treatments in patients with degenerative cervical myelopathy (DCM). During one-year follow-up period, we evaluated patient-reported functional and quality of life (QOL) measures.
Methods: In a retrospective single-center study, we collected data of patients with DCM who underwent cervical fusion surgeries in Imam Khomeini Hospital, Tehran, Iran, from 2011 to 2015. Patients underwent single or multi-level anterior cervical discectomy and fusion (ACDF), anterior cervical corpectomy and fusion (ACCF), or posterior laminectomy and fusion. We utilized patient-reported assessments including Short Form 36 (SF-36), Visual Analogue Scale (VAS), Neck Disability Index (NDI), and Nurick grade. Follow-up was performed at 6 weeks, 3 months, 6 months, and 12 months post-operatively to assess the outcome of surgery.
Results: Ninety patients (56 men, 34 women) with a mean age of 54.1 (27-87) years were included. Comparison of pre- and post-operative scores showed significant improvement in SF-36 parameters, VAS, NDI, and Nurick grade ($P < 0.001$). Also, women's VAS scores improved more than men's VAS scores during the follow-up period ($P < 0.050$). Age and type of surgery did not significantly affect the SF-36 parameters, VAS, NDI, and Nurick grade ($P > 0.05$).
Conclusions: Cervical surgeries in patients with different severity of DCM can improve different aspects of QOL during one-year after surgery.

Keywords: Cervical Vertebrae; Intervertebral Disc Degeneration; Spinal Fusion; Patient Outcome Assessment; Quality of Life

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Background

Cervical myelopathy is a common disorder of the spine that can cause impairment of motor, sensory, and bladder function (1). Different pathological processes such as ossification of posterior longitudinal ligament (OPLL), cervical disc herniation, and cervical spondylosis can cause degenerative cervical myelopathy (DCM) (2). It is the most common spinal cord disorder among elderly patients. Structural changes such as OPLL, hypertrophy of yellow ligament, and osteophyte formation result in spinal cord compression and dysfunction (3). Patients with DCM experience different signs and symptoms, such as pain in the neck and arms, paresthesia and weakness of the limbs, gait difficulties, or bowel and bladder dysfunction (4). Surgical approaches like anterior cervical discectomy and fusion (ACDF), anterior cervical corpectomy and fusion (ACCF), and posterior approaches for the treatment of DCM have different outcomes (5-9). To date, only a few studies have evaluated the quality of life (QOL), disability, and functional improvement of the patients with DCM after cervical surgery using Patient-Reported Outcome (PRO) questionnaires.

The purpose of this study is to determine patient-reported functional and QOL outcomes in DCM after cervical surgeries.

Methods

In this retrospective single-center study, we included patients with DCM who underwent single or multi-level ACDF, ACCF, or posterior laminectomy and fusion, in Imam Khomeini Hospital, Tehran, Iran, between 2011 and 2015. The study protocol was approved by the Ethical Committee of Tehran University of Medical Sciences, Tehran, Iran. All patients signed the informed consent to be included in the study retrospectively.

Patients were included based on positive medical history, the presence of clinical signs and symptoms of myelopathy (e.g., weakness of upper limb, gait difficulties, spasticity, patchy sensory loss, bladder/bowel dysfunction, increased deep tendon reflexes, positive Hoffman's sign), and confirmatory radiographic modalities such as magnetic resonance imaging (MRI).

The exclusion criteria were as follows: central cord syndrome (CCS) or trauma, cervical spine infection or tumors, history of previous neck surgeries, history of an underlying disease such as rheumatologic disease, severe ischemic disease, lung disorders, and neurological disorders such as multiple sclerosis (MS) and Parkinson's disease (PD).

Patient-reported surveys including Short Form 36 (SF-36) (10), Visual Analogue Scale (VAS) for pain (11), Neck Disability Index (NDI) (12), and Nurick grade (13) were obtained pre-operatively and at 6 weeks, 3 months, 6 months, and 12 months after surgery. All procedures were done by a single surgeon. All patients completed the questionnaires under the supervision of a trained physician, who was responsible for answering the questions.

The SF-36 is a widely-used health measurement scale with eight aspects of QOL: bodily pain (BP), role-physical (RP), physical function (PF), general health (GH), social

function (SF), role-emotional (RE), vitality (VT), and mental health (MH). These eight parameters can be summarized into physical component summary (PCS) and mental component summary (MCS). All parameters of SF-36, PCS, and MCS are scored on a 0-100 scale, with higher number reflecting better health outcomes (10). The VAS is a single-item scale for assessing the pain intensity, with scores ranging from 0 (no pain) to 10 (worst pain ever experienced) (11). NDI is a self-reported disability index, which is scored on a 50-point scale: 0-4 no disability, 5-14 mild disability, 15-24 moderate disability, 25-34 severe disability, and 35-50 complete disability (12). The Nurick grade evaluates the ambulatory status of a patient and is categorized in five stages, ranging from 0 (signs or symptoms of root involvement but without evidence of spinal cord disease) to 5 (chair-bound or bedridden) (13).

We used SPSS software (version 18, SPSS Inc., Chicago, IL, USA) for statistical analysis. The results are expressed as mean ± standard deviation (SD). The parameters of SF-36, VAS, NDI, and Nurick grade were compared before and after surgery using repeated measures analysis of variance (ANOVA). We also used paired t-test to find any significant difference between each post-operative time point and baseline scores. A P-value < 0.05 was considered significant.

Results

We included 90 patients, 56 men (62.2%) and 34 women (37.8%). The age of patients ranged from 27 to 87 years (54.16 ± 6.50). The patients underwent single-level ACDF (42 patients), two-level ACDF (20 patients), three-level ACDF with plate fixation (10 patients), ACCF (2 patients), and posterior laminectomy and fusion (16 patients). Table 1 shows a summary of patients' characteristics.

The only complication was superficial wound infection in 3 patients, all of whom underwent ACDF. Analyzing t-test on VAS scores showed significant improvement in pain intensity at all follow-up time points (P < 0.001). Post-operative NDI disability scores significantly decreased at all follow-up evaluations (P < 0.001). The mean Nurick scores showed functional improvement in all patients (P < 0.050). SF-36 survey showed significant improvement in all components, as well as PCS and MCS (P < 0.001, repeated measures ANOVA). Only MCS scores at 6-week follow-up improved significantly in comparison to pre-operative values (P < 0.050, paired two-sample t-test, Table 2).

Table 1. Baseline Characteristics of the Patients (n = 90)

Parameters	Value
Sex	
Female	34 (37.7)
Male	56 (62.3)
Age (year)	54.16 ± 6.50
Surgery	
Single-level ACDF	42 (46.6)
Two-level ACDF	20 (22.2)
Three-level ACDF	10 (11.2)
Posterior approach	16 (17.8)
ACCF	2 (2.2)
BMI (kg/m^2)	26.73 ± 4.89
Smoker	26 (28.8)
Preoperative VAS	8.35 ± 1.43
Preoperative Nurick grade	2.26 ± 1.21
Preoperative SF-36	
PCS	33.58 ± 9.01
MCS	34.68 ± 7.82
Preoperative NDI	
Moderate disability	32 (35.5)
Severe disability	40 (44.5)
Complete disability	18 (20.0)

Data are presented as mean ± standard deviation (SD) or number (percentage)
ACDF: Anterior cervical discectomy and fusion; ACCF: Anterior cervical corpectomy and fusion; MCS: Mental component summary; PCS: Physical component summary; NDI: Neck Disability Index; SF-36: Short Form 36; VAS: Visual Analogue Scale; BMI: Body mass index

Table 2. Patient-Reported Assessments at Pre-Operation, 6 Weeks, 3 Months, 6 Months, and 12 Months after Surgery

Parameter	Pre-operation	6 weeks post-operation	3 months post-operation	6 months post-operation	12 months post-operation
VAS	8.31 ± 1.43	7.69 ± 1.41^{NS}	5.20 ± 1.32	3.70 ± 1.23	2.00 ± 0.80
NDI	28.27 ± 7.19	18.13 ± 6.06^{NS}	13.02 ± 4.74	12.08 ± 4.26	9.06 ± 3.80
Nurick grade	2.46 ± 1.21	2.17 ± 1.15^{NS}	1.70 ± 0.94	1.30 ± 0.90	1.13 ± 0.84
SF-36					
PF	32.33 ± 12.64	34.22 ± 19.97^{NS}	43.56 ± 10.42	46.23 ± 12.52	49.78 ± 11.02
SF	25.00 ± 15.30	28.05 ± 15.80^{NS}	50.00 ± 18.07	47.22 ± 16.18	53.05 ± 19.24
RP	27.77 ± 17.94	27.22 ± 16.70^{NS}	51.11 ± 16.81	47.22 ± 17.04	52.22 ± 17.53
RE	37.00 ± 20.35	40.70 ± 17.22^{NS}	54.02 ± 17.80	56.24 ± 15.59	55.49 ± 17.78
MH	29.33 ± 9.57	31.10 ± 9.41^{NS}	31.64 ± 8.64	33.60 ± 7.83	39.46 ± 9.74
VT	29.33 ± 9.86	32.11 ± 10.14^{NS}	41.88 ± 8.14	45.34 ± 9.49	48.56 ± 9.86
BP	33.00 ± 9.08	33.98 ± 8.70^{NS}	33.38 ± 7.33	41.00 ± 7.19	41.50 ± 8.85
GH	31.40 ± 12.08	33.22 ± 12.20^{NS}	43.22 ± 9.95	45.88 ± 10.72	48.77 ± 10.17
PCS	33.58 ± 9.01	34.17 ± 8.20^{NS}	36.79 ± 9.35	38.73 ± 7.99	43.31 ± 9.02
MCS	34.68 ± 7.82	37.60 ± 8.26	38.80 ± 7.30	42.04 ± 6.14	46.59 ± 6.57

Data are presented as mean ± standard deviation (SD); ^{NS}Non-significant compared with preoperative values
PF: Physical function; SF: Social function; RP: Role-physical; RE: Role-emotional; MH: Mental health; VT: Vitality; BP: Bodily pain; GH: General health; PCS: Physical component summary; MCS: Mental component summary; SF-36: Short Form 36; NDI: Neck Disability Index; VAS: Visual Analogue Scale

At 3-, 6,- and 12-month evaluations, all of the tests (VAS, NDI, Nurick grade, all parameters of SF-36, PCS, and MCS) improved significantly compared to the baseline. Also, women's VAS scores improved more than men's scores during the follow-up ($P < 0.050$, t-test). However, age and type of surgical approaches did not significantly affect the improvement of VAS, Nurick grade, NDI, and parameters of SF-36 ($P > 0.050$, t-test).

To assess the effect of disease severity on 12-month outcome, we allocated the patients into five groups based on pre-operative NDI scores. None of the SF-36 parameters, VAS, or Nurick grade showed significant difference between disability groups at 12-month follow-up (Table 3).

Table 3. 12-Month Outcomes Based on Pre-Operative Neck Disability Index (NDI) Scores

	Moderate disability	Severe disability	Complete disability	P-value
NDI	7.53 ± 2.22	10.02 ± 3.14	12.42 ± 5.36	0.004
Nurick grade	0.87 ± 0.67	1.05 ± 0.68	1.77 ± 1.20	0.057
VAS	2.00 ± 0.89	2.20 ± 0.76	47.70 ± 7.00	0.592
SF-36				
PF	50.01 ± 12.21	50.52 ± 9.82	47.70 ± 12.27	0.830
SF	53.94 ± 18.00	57.50 ± 19.63	41.60 ± 17.64	0.119
RP	54.65 ± 18.70	55.05 ± 15.30	41.60 ± 17.65	0.130
RE	54.10 ± 20.62	58.20 ± 18.32	51.80 ± 17.53	0.659
MH	42.50 ± 8.23	37.82 ± 10.10	37.70 ± 10.94	0.307
VT	51.82 ± 10.40	47.20 ± 9.90	45.50 ± 7.67	0.228
BP	43.01 ± 7.13	42.72 ± 7.23	36.00 ± 13.04	0.118
GH	50.90 ± 10.30	48.70 ± 10.21	45.02 ± 9.64	0.384
PCS	42.73 ± 6.72	43.46 ± 9.61	44.10 ± 11.73	0.930
MCS	46.62 ± 7.50	46.43 ± 5.80	46.74 ± 6.52	0.992

Data are presented as mean ± standard deviation (SD)
NDI: Neck Disability Index; VAS: Visual Analogue Scale; SF-36: Short Form 36; PF: Physical function; SF: Social function; RP: Role-physical; RE: Role-emotional; MH: Mental health; VT: Vitality; BP: Bodily pain; GH: General health; PCS: Physical component summary; MCS: Mental component summary

Discussion

DCM has been suggested as the most common spinal cord disorder in the elderly, which results in chronic and progressive changes in the spinal cord (2, 14, 15). According to the previous studies, surgical treatment of DCM is associated with satisfactory results (16, 17). The outcome of surgery can be assessed with objective functional tests or subjective patient-reported evaluations (18, 19). In this retrospective single-center study, we analyzed pre-operative and follow-up data of 90 patients with DCM who underwent surgical treatment. The attending surgeon used different surgical approaches based on each patient's condition to achieve proper decompression and stabilization of the spinal cord.

The VAS scores showed significant improvement at 6 weeks, 3 months, 6 months, and 12 months, which is in accordance with previous studies (20, 21). Analysis of Nurick grade showed a significant decrease from baseline to all follow-up points, which is similar to the previous findings (8, 22, 23). The NDI scores significantly decreased at all the follow-up evaluations, which demonstrates the effective role of surgical treatment in disability improvement.

The SF-36 questionnaires showed improvement in all scores, as well as PCS and MCS, at 3 months, 6 months, and one year after the surgery regardless of sex, age, and surgical technique. This is consistent with the findings of Epstein and Epstein that showed improvement in eight SF-36 items at 1 year, with the maximum improvement in the first 6 months (22). At 6 weeks, we observed statistically significant improvement only in MCS. Fehlings et al. reported similar results with no significant improvement in SF-36 scores except in one item (PF) at 3 months after surgery (8). Factors like surgical site pain and restriction caused by surgical wound may explain this inconsistency (24-27).

Comparing the improvement of VAS, Nurick, and SF-36 at 12 months after surgery based on pre-operative severity showed no significant differences among these groups. This finding was consistent with a large study conducted in North America that classified patients based on pre-operative scores of modified Japanese Orthopaedic Association (mJOA). The study showed no significant difference among three groups of mild, moderate, or severe disease in one year (8). This evidence shows that patients with DCM benefit from surgical treatment over time, regardless of pre-operative disease severity.

The only complication we observed was surgical site infection in three patients (6.6%), all of whom underwent ACDF. The infection was superficial and it was treated completely by administration of intravenous (IV) cefazolin. These complications did not affect patient improvement according to our assessments.

Our study was limited by retrospective design, small number of patients, and lack of subgroup analysis. We believe that a multi-center study on a larger scale with longer follow-up period is required to determine the optimal surgical approach in DCM and address the patients with different levels of pre-operative disease severity.

Conclusion

Cervical surgeries in patients with different severity of DCM can improve different aspects of QOL during one-year follow-up.

Conflict of Interest

The authors declare no conflict of interest in this study.

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