

Effect of Anterior Cervical Decompression and Fusion for Cervical Myelopathy Treatment

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Conflict of interest:

Funding agency:

Contribution to authors: Dr. Md. Moshir Rahman, Dr. Md. Motasimul Hasan

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Editorial formatting: Prof. Dr. Md. Shafiqul Islam, Prof. Mohammad Hossain

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Received: 25 January, 2023

Accepted: 24 February 2023

Abstract

Background: Cervical myelopathy is a common cause for neurosurgical outpatient department visit, and a substantial proportion of patient suffering from myelopathy due to cervical spondylosis has to go through surgical management, commonly anterior cervical decompression and fusion in the form of Cloward's procedure, Smith Robinson procedure, PEEK and Titanium cage implant and fusion. A total of 23 cases were selected according to predefined inclusion and exclusion criteria.

Method: This is a prospective study that was conducted in the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University. Patients with cervical myelopathy undergoing anterior cervical decompression and fusion, in the form of Cloward's procedure, Smith Robinson procedure, or Anterior Cervical Discectomy with Poly Ether Ether Ketone (PEEK) and Titanium cage implants in a single level for inclusion and exclusion criteria.

Results: This study found out that the Modified Nurick grading system is a useful tool to quantify the functional status of the patients suffering from cervical myelopathy and surgery in various forms of anterior cervical decompression and fusion has an impact on the functional status even at an early period of one month. 82.6% of the patients had functional improvement, whereas 13% remained the same. Only one out of the 23 patients deteriorated. Various methods of anterior cervical decompression and fusion or the levels of involvement did not have any statistically significant impact on improvement among the patients.

Conclusion: Anterior cervical decompression and fusion is a time-proven treatment modality for the patients suffering from cervical myelopathy owed to external compression due to spondylotic changes and Ossified Posterior Longitudinal Ligament. The functional status of the patients that have been compromised due to the disease shows promising change even in the early period undergoing surgery.

Keywords: Cervical Myelopathy, Poly Ether Ether Ketone, Spondylotic, Ossified Posterior Longitudinal Ligament

Bang. J Neurosurgery 2023; 13(1): 3-9

Introduction:

Cervical spondylosis is defined as a chronic degenerative process involving the cervical spine¹. Cervical spondylosis is widespread in all cross-sections of the adult population; it has been estimated that 50% of the population over the age of 50 years

and 75% over the age of 65 years have the disease. It is indeed fortunate that only a small proportion develop the most serious complication of the disease, namely, cervical spondylotic myelopathy (CSM). CSM can lead to devastating and crippling neurological deficits². Cervical spondylotic myelopathy (CSM) results from

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a congenitally narrow spinal canal, degenerative changes of intervertebral discs, and formation of osseous spurs (spondylosis) of the cervical vertebrae. The disorder of the spinal cord (myelopathy) can occur along with cervical nerve roots irritation (radiculopathy). Although the association of cervical spondylosis with radiculopathy and myelopathy is now well understood, it was not until the 19th century that a causative relationship between anatomic compression of neurological structures and the clinical development of neurological symptoms became apparent.

Sagittal plane compression of the cervical spinal cord
 It was Sir Victor Horsley who first presented the results of his surgical experience in treating seven patients with caries (tuberculosis) and trauma of the cervical spine at the Annual Meeting of the Surgery Section of the British Medical Association on August 25, 1895 [1]. Predicting a patient's potential for functional recovery before and after surgical decompression remains elusive largely due to the uncertain natural progression of spinal cord pathophysiology. Spinal cord axonal loss and inflammation has recently been reported to play a crucial role in the progression of CSM³. CSM is the most common acquired cause of spinal cord dysfunction. Described first by Stookey (1928), it was initially attributed to cord compression by cartilaginous nodules of the degenerated disc material.

from the primary degenerative pathological lesion of cervical spondylosis is the most frequently cited cause of myelopathy in this condition. The compression may occur ventrally via spondylotic bars and/or dorsally from a bulging ligamentum flavum. This problem is worse with cervical kyphosis. Furthermore, during flexion, there is a deformation of the lateral and ventral⁴.

Objective

General Objective

To evaluate the functional status by Modified Nurick Grading system, in patients who underwent anterior cervical decompression and fusion (ACDF) for cervical spondylotic myelopathy.

Specific Objective

- To record the pre-operative functional status using Modified Nurick grade.
- To record the post-operative functional status using Modified Nurick grade after 1 month of surgery.

- To find out if there is any statistically significant improvement in Modified Nurick Grades of patients after surgery.

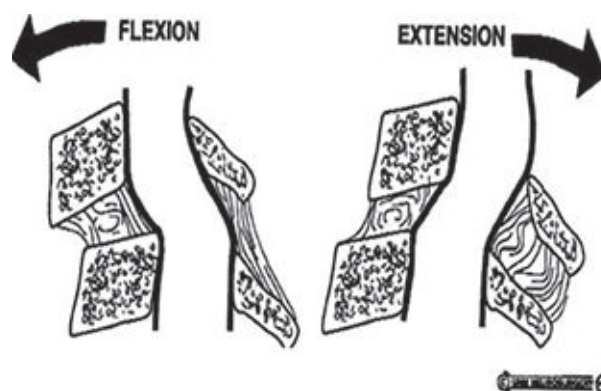


Fig.-1: The lateral view of the cervical spine with spondylosis showing the pincer mechanism in flexion and extension, (from, Benzel EC: Biomechanics of Spine Stabilization. Rolling Meadows, American Association of Neurological Surgeons Publications, 2001)

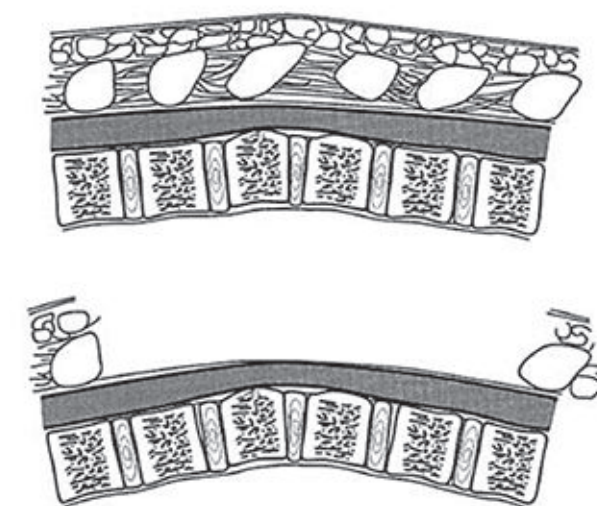


Fig.-2: A, a kyphosis associated with cervical spondylosis causes neural injury, in part, by tethering the spinal cord over a ventral mass via the "sagittal bowstring" effect. B, dorsal decompression (i.e., via laminectomy) may worsen deformation, (from, Benzel EC: Biomechanics of Spine Stabilization. Rolling Meadows, American Association of Neurological surgeons 2001)

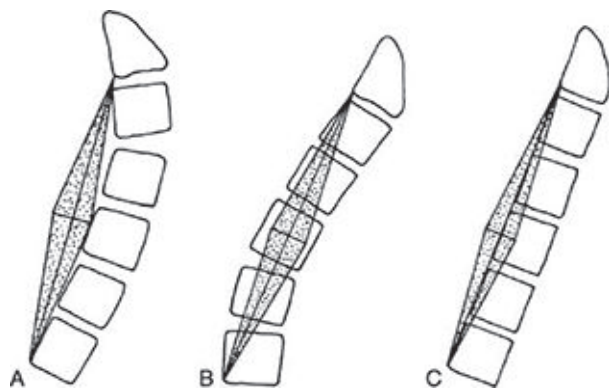


Fig.-3: A, a midsagittal section of the cervical spine configured in lordotic posture (“effective” cervical lordosis). A line has been drawn from the dorsocaudal aspect of the vertebral body of C2 to the dorsocaudal aspect of the vertebral body of C7 (solid line). The gray zone is outlined by the other lines. A midsagittal section of a cervical spine in kyphosis (“effective” cervical kyphosis). B, note that portions of the vertebral bodies are located dorsally to the gray zone. C, a midsagittal section of a “straightened” cervical spine. Note that the dorsal aspects of the vertebral bodies are located within, but not dorsally to, the gray zone, (from, Benzel EC: *Biomechanics of Spine Stabilization*. Rolling Meadows, American Association of Neurological Surgeons Publications, 2001).

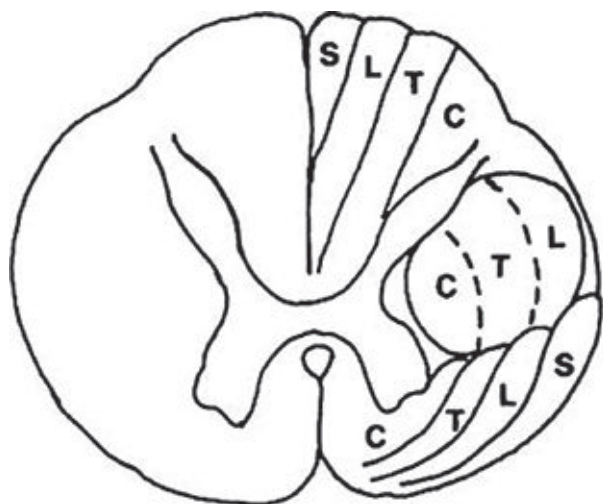


Fig.-4: Diagrammatic axial sections of the spinal cord demonstrating the somatotropic orientation of the spinal tracts. The zone of “butterfly” partial necrosis is observed in the cervical spinal cord of patients with cervical spondylotic myelopathy. The necrosis affects the lateral columns, lateral portion of the central gray matter, and ventral portions of the dorsal column (from, Benzel EC: *Biomechanics of Spine Stabilization*. Rolling Meadows, American Association of Neurological Surgeons Publications, 2001)

Material and Methods

Study type: Prospective study

Place of study: Department of Neurosurgery, BSMMU

Period of study: 1 year after clearance from IRB. January 2016 to February 2017.

Study population: All patients diagnosed with cervical spondylotic myelopathy in a single level in MRI undergoing anterior cervical decompression surgery in the Department of Neurosurgery, Bangabandhu Sheikh Mujib Medical University, National Institute of Neuroscience, Dhaka Medical College, and private hospitals of Dhaka were included in the study.

Sample Size: 23

Sample Technique: Purposive sampling

Inclusion Criteria

- Patients diagnosed as a case of cervical spondylotic myelopathy both clinically and on MRI of the cervical spine (done minimum at 1.5 Tesla MRI machine) and
- Patients who have undergone anterior cervical decompression surgery

Exclusion Criteria

- Patients of CSM having MRI of cervical spine done at less than 1.5 Tesla MRI machine.
- Patients with dorsal and lumbosacral pathology.
- Patients having OPLL (Ossified Posterior Longitudinal Ligament) and spinal tumor.
- Patients with any of the following co-morbidities: previous spinal surgery, cerebral palsy, rheumatoid arthritis, cerebrovascular disease, spinal trauma.
- Posterior approaches for decompression were excluded

Data Collection Instrument

Data was collected using a data collection sheet. Posterior approaches for decompression were excluded from the study. Preoperative functional status using the Modified Nurick grade was recorded and the questionnaires were filled up. Then after surgery at one-month follow-up, the Modified Nurick grades were recorded again in the out-patient room. The patients not showing up for the follow-up visit were called and asked to visit the outpatient room.

Data Collection Procedure

1. Data was collected from the Department of Neurosurgery; BSMMU and Dhaka Medical College Hospital subjects were included after the primary screening with inclusion and exclusion criteria.
2. At admission, a detailed history of the illness was taken from the patient, and thorough general and neurological examinations.
3. Signal intensity change in the spinal cord on MRI of cervical spine recorded and analyzed.
4. A data collection sheet is used to collect the necessary information.
5. Informed written consent was taken from each participant or guardian before data collection
6. The score of a functional status of the patients as per the Modified Nurick grading system on admission, before surgery, and one month after surgery was documented.

Assessment of Neurological Function

The clinical grade of the cervical myelopathy was evaluated according to the modified Nurick grade for myelopathy just before surgery and at the final follow-up assessment. The modified Nurick grade was used to calculate the recovery rate (RR) by using a formula similar to that used in the Japanese Orthopedics Association score for cervical myelopathy. Recovery rate (%) = (postoperative modified Nurick Score - preoperative modified Nurick Score) / (6 - preoperative modified Nurick Score) x 100.

Statistical analysis

Data were processed and analyzed by using computer software SPSS (statistical package for social sciences) version 20. Results are described in frequencies or percentages. Statistical comparison was done using the Paired T-test and Pearson Chi-square tests. P-value of <0.05 was considered statistically significant.

Ethical Consideration

Ethical clearance for the study was taken from the department of neurosurgery and central ethical committee, Bangabandhu Sheikh Mujib Medical University. Patients and their relatives were informed in detail about the study, its merits and demerits explained to them in easy and understandable language, and then informed consent was taken. It

was assured that all information and records were kept confidential and the procedure was helpful for both the attending neurosurgeon and the patients in making decisions for management. The patients were identified by a unique registration number and their identities were kept confidential and addressed only by the researcher.

Results:

Table 1 shows the distribution of respondents according to age. Mean age was: 47.65 ± 9.82 years and range (30-70 years). In our study, the maximum patients were up to 40 years old and only 7 patients were below 40 years. See below the age distribution in table 1.

Table-I

Distribution of Respondents according to age (n-23)

Age (years)	Frequency (n)	Percentage (%)
<40	7	30.4
41 – 50	8	34.8
>50	8	34.8
Total	23	100.0

Table 2 shows the gender distribution among the patients. In this study, male patients were predominant. Here, 65.2% were male and 34.8% were female. See table 2-

Table-II

Distribution of the patients according to gender (n-23)

Gender	Frequency (n)	Percentage (%)
Male	15	65.2
Female	8	34.8
Total	23	100.0

Table 3 shows the frequency of patients presenting with myelopathy at different grades according to the Modified Nurick Grading system for clinical/functional assessment. During the admission time, most of the patients (47.85%) were presented with Modified Nurick score 3, 17.4% patients presented with Modified Nurick score 2 & 5, 13% patients with Modified Nurick score 4, and 4.3% patients with Modified Nurick score 6. At one-month follow-up, no patients were in grade 1, 4.3% patients found in Grade 2, 13% patients in grade 3, 30.4% patients in grade 4, and 26.1% patients were in grade 5 & 6 respectively.

Table-III
Distribution of the patient's according to Modified Nurick score at admission and after one month of operation (n-23)

Modified Nurick score	At admission		After 01 months of operation	
	Frequency(n)	Percentage(%)	Frequency(n)	Percentage(%)
1	0	0.0	0	0.0
2	4	17.4	1	4.3
3	11	47.8	3	13.0
4	3	13.0	7	30.4
5	4	17.4	6	26.1
6	1	4.3	6	26.1

Table 4 shows that the most involved disc level was C5/6 level (52.2%), C4/5 was second highest involved (21.7%), followed by C3/4 (17.4%) and C6/7 (8.7%). See table 4 below-

Table-IV
Levels of Intervertebral disc involvement in patients (n-23)

Level of Intervertebral Disc Involvement	Frequency (n)	Percentage (%)
C3/4	4	17.4
C4/5	5	21.7
C5/6	12	52.2
C6/7	2	8.7

Figure 5 shows that most of the patients were improved according to the Modified Nurick Grading system. Improvement was seen in 19 patients (83%), 3 patients remained unchanged (13%) and 1 patient deteriorated (4%). Improvement or deterioration was defined as a change of Modified Nurick Score by a minimum of 1 grade.

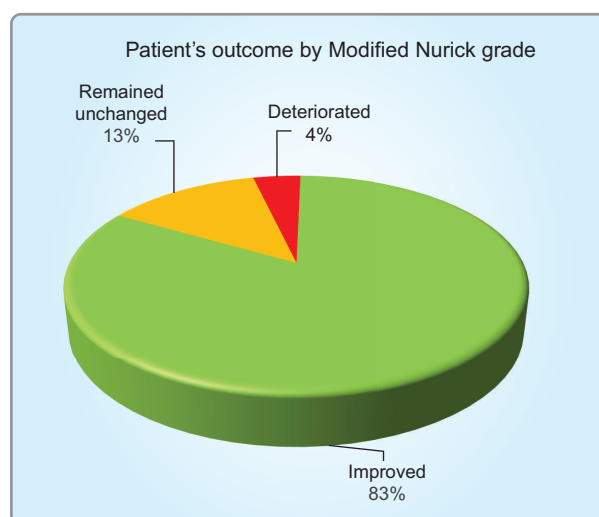


Fig.-5: Patients outcome according to the Modified Nurick Grade.

Table 5 shows the comparison of the outcome of surgery in different techniques of ACDF surgery. There was no statistically significant difference found in the

Table-V
Outcome of different techniques of ACDF surgery (n-23)

The technique of ACDF surgery	Outcome			P-value
	Improved	Remained unchanged	Deteriorated	
ACDF by Cloward's procedure	2 (10.5)	1 (33.3)	0 (0.0)	0.751(ns)
ACDF Titanium cage	14 (73.7)	2 (66.7)	1 (100.0)	
ACDF Peek cage	3 (15.8)	0 (0.0)	0 (0.0)	
Total	19 (100.0)	3 (100.0)	1 (100.0)	

*Chi-square test was done to measure the level of significance, ns= not significant

outcomes among patients who underwent different techniques of ACDF surgery.

The mean Modified Nurick score before surgery was 3.43 ± 1.12 and the mean postoperative Nurick score after one month of ACDF surgery was 4.56 ± 1.16 . A paired T-Test was done to measure the level of significance. Post-operative Modified Nurick score was significantly higher than before surgery (Table 6).

Table-VI

Modified Nurick score before and after 1 month of ACDF operation of patients (n-23)

Modified Nurick score	Before operation	One month after operation	P-value
Mean \pm SD	3.43 ± 1.12	4.56 ± 1.16	<0.001
Range (Min-Max)	2 – 6	2 - 6	

*Paired T-test was done to measure the level of significance.

Discussion:

Cervical spondylotic myelopathy causes upper limb, lower limb, and sphincter dysfunctions. Surgical decompression is effective in relieving these symptoms. Though many studies are demonstrating good neurological recovery after surgical decompression for cervical spondylotic myelopathy, few studies are showing the timely manner of the neurological recovery and pattern of neurological recovery⁵. Progression of myelopathy may be arrested by surgical decompression. This is not always borne out and some early series showed similar results with conservative treatments as with laminectomy, which yielded improvement in 56%, no change in 26%, and worsening in 19%⁶.

Most of the studies showed that cervical myelopathy patients' age range is variable and wide but the majority of the cases belong to an advanced age group. Furlan et al (2011) did a prospective study on clinical outcomes of 81 patients and the mean age was 57 years (range 32-88 years)⁷. Epstein (2011) analyzed the efficacy of ACDF and on 60 patients and in her series, the mean age was 47 years (range 31-71 years). In this study, the mean age of patients was 47.65 years (range 30-70 years)⁸.

Burkhardt et al (2013) did a comparative study on outcomes of anterior cervical discectomy and fusion with anterior cervical corpectomy and fusion and found

similar results in terms of outcome⁹. Among the 118 patients in that series, 38 patients (32%) underwent corpectomy whereas 80 (68%) underwent anterior cervical discectomy and fusion. A prospective outcome study was done comparing anterior cervical discectomy and fusion with autologous tricortical bone graft by Smith Robinson Procedure and PEEK cage¹⁰. The study aimed to evaluate the clinical outcome of ACDF through different techniques and concluded that the clinical outcome was similar in both patient groups where 181 among 258 (70.2%) were fused with autologous bone graft and 77 (29.8%) by PEEK cage¹⁰.

In this study, posterior approaches for the treatment of such conditions were excluded. In the study population, most of the patients 17(73.9%) underwent anterior cervical discectomy and fusion by Titanium mesh cage with autologous bone graft, 3(13%) by PEEK cage, and 3 (13%) by Cloward's procedure. Modified Nurick grades measuring the functional status of the patients vary at the time of presentation. Most of the patients in our country seek medical attention when they can no longer work and provide for themselves and their families. Epstein (2011) quantified functional status according to Nurick Grades and calculated a mean of 3.3 in 60 patients undergoing surgery⁸.

The mean Nurick grade of patients was 2.4 in another series of 119 patients¹¹. A prospective multicenter study conducted by AO Spine North America on 278 patients found preoperative Mean Nurick Grade was 3.14⁹. In this study, the mean Modified Nurick Grade was 3.43 at the time of presentation. Fehlings et al (2013), in a series of 260 patients, calculated the mean Nurick Grade of 3.11 at the time of diagnosis and 1.52 after one year of surgery with a significant difference of 1.59¹². In a study on 57 consecutive patients undergoing anterior discs at various levels¹². Lied et al (2010) found involvement of C5-6 level in 266 patients in a series of 390 cases which is 68%, followed by involvement of C6-7 level in 207 (53%) and 56 patients (14%) had involvement at C4-5 level¹⁰. Another large series of 379 patients diagnosed localization of discs at various levels¹³. Among the 379 patients, the C6-7 level was involved in 219 patients (57.7%), C5-6 involved in 161(42.2%). C4-5 in 34(8.9%), C3-4 in 7(1.8%) and C7-T1 in 300.9%) patients. In a series of 120 patients undergoing anterior cervical discectomy and fusion with one year follow

up, an improvement of mean Nurick Grade 1.36 was calculated¹⁴.

In this study, the patients had undergone different forms of anterior cervical discectomy and fusion, such as the Cloward's procedure, the Modified Smith-Robinson procedure, fusion with PEEK and Titanium Cages. There was no statistically significant difference found in the outcome of the surgery as far as the functional status of the patient is concerned. Most of the surgeries had similar outcomes and this is found in several international studies to be similar.

The study population was limited to patients having single levels of involvement only and two or more level diseases were excluded.

Conclusion

The outcome in this study was defined through Modified Nurick Grading and analysis was done to measure the preoperative and postoperative Nurick Grades after one month. The study found out that there are statistically significant improvements in the functional status of patients as quantified by the Modified Nurick Grade in the patients that underwent Anterior Cervical Decompression and Fusion.

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